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NATIONAL DAM SAFETY PROGRAM. MALAGA DAM (NJ00443), ATLANTIC COA--ETC(U)
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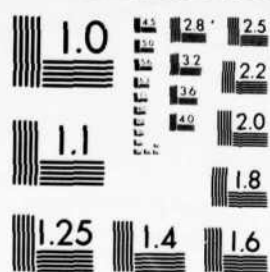
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SCOTLAND RUN, GLOUCESTER COUNTY
NEW JERSEY

LEVEL

MALAGA DAM
NJ 00443

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM



DEPARTMENT OF THE ARMY

Philadelphia District
Corps of Engineers
Philadelphia, Pennsylvania

February, 1979



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19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Dams Visual Inspection Embankments National Dam inspection Act. Structural analysis Malaga Dam, N.J. Safety		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report cites results of a technical investigation as to the dam's ade- quacy. The inspection and evaluation of the dam is as prescribed by the National Dam Inspection Act, Public Law 92-367. The technical investigation includes visual inspection, review of available design and construction records, and preliminary structural and hydraulic and hydrologic calculations, as applicable. An assessment of the dam's general condition is included in the report.		



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DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
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Honorable Brendan T. Byrne
Governor of New Jersey
Trenton, NJ 08621

26 APR 1979

Dear Governor Byrne:

Inclosed is the Phase I Inspection Report for Malaga Dam in Gloucester County, New Jersey which has been prepared under authorization of the Dam Inspection Act, Public Law 92-367. A brief assessment of the dam's condition is given in the front of the report.

Based on visual inspection, available records, calculations and past operational performance, Malaga Dam, initially listed as a high hazard potential structure but reduced to a low hazard potential structure as a result of this inspection, is judged to be in good overall condition. However, the dam's spillway is considered inadequate since 17 percent of the Spillway Design Flood - SDF - would overtop the dam. (The SDF, in this instance, is one half of the Probable Maximum Flood.) The low hazard potential classification means that in the event of failure of the dam, no loss of life and only minimal economic loss is expected. For the same reasons no further studies or increase of spillway capacity are recommended. To assure continued functioning of the dam and its impoundment, the following actions could be undertaken by the owner:

- (1) Regrade and provide slope protection for the eroded downstream embankment areas at the ends of the bridge wingwalls on the south side.
- (2) Construct slope paving on the downstream embankment at the roadway profile low point.
- (3) Remove trees on the downstream embankment slopes to lessen the piping potential.
- (4) Repair or replace the deteriorated timber bulkhead along the upstream side of the embankment.

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NAPEN-D

Honorable Brendan T. Byrne

A copy of the report is being furnished to Mr. Dirk C. Hofman, New Jersey Department of Environmental Protection, the designated State Office contact for this program. Within five days of the date of this letter, a copy will also be sent to Congressman James J. Florio of the First District. Under the provision of the Freedom of Information Act, the inspection report will be subject to release by this office, upon request, five days after the date of this letter.

Additional copies of this report may be obtained from the National Technical Information Services (NTIS), Springfield, Virginia 22161 at a reasonable cost. Please allow four to six weeks from the date of this letter for NTIS to have copies of the report available.

An important aspect of the Dam Safety Program will be the implementation of the recommendations made as a result of the inspection. We accordingly request that we be advised of proposed actions taken by the State to implement our recommendations.

Sincerely,

1 Incl
As stated

James G. Ton
JAMES G. TON
Colonel, Corps of Engineers
District Engineer

Copies furnished:

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MALAGA DAM (NJ00443)

CORPS OF ENGINEERS ASSESSMENT OF GENERAL CONDITIONS

This dam was inspected on 5 December 1978 by Louis Berger and Associates, Inc. under contract to the State of New Jersey. The state, under agreement with the U. S. Army Engineer District, Philadelphia, had this inspection performed in accordance with the National Dam Inspection Act, Public Law 92-367.

Malaga Dam, initially listed as a high hazard potential structure but reduced to a low hazard potential structure as a result of this inspection, is judged to be in good overall condition. However, the dam's spillway is considered inadequate since 17 percent of the Spillway Design Flood - SDF - would overtop the dam. (The SDF, in this instance, is one half of the Probable Maximum Flood.) The low hazard potential classification means that in the event of failure of the dam, no loss of life and only minimal economic loss is expected. For the same reasons no further studies or increase of spillway capacity are recommended. To assure continued functioning of the dam and its impoundment, the following actions could be undertaken by the owner:

- (1) Regrade and provide slope protection for the eroded downstream embankment areas at the ends of the bridge wingwalls on the south side.
- (2) Construct slope paving on the downstream embankment at the roadway profile low point.
- (3) Remove trees on the downstream embankment slopes to lessen the piping potential.
- (4) Repair or replace the deteriorated timber bulkhead along the upstream side of the embankment.

APPROVED:

James G. Ton
JAMES G. TON

Colonel, Corps of Engineers
District Engineer

DATE:

26 April 79

PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM

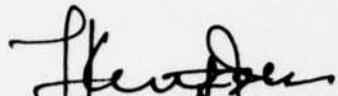
Name of Dam Malaga Dam Fed ID# NJ 00443
New Jersey ID# 31-24

State Located New Jersey
County Located Gloucester
Coordinates Lat. 3934.4 - Long. 7503.6
Stream Scotland Run
Date of Inspection 5 December 1978

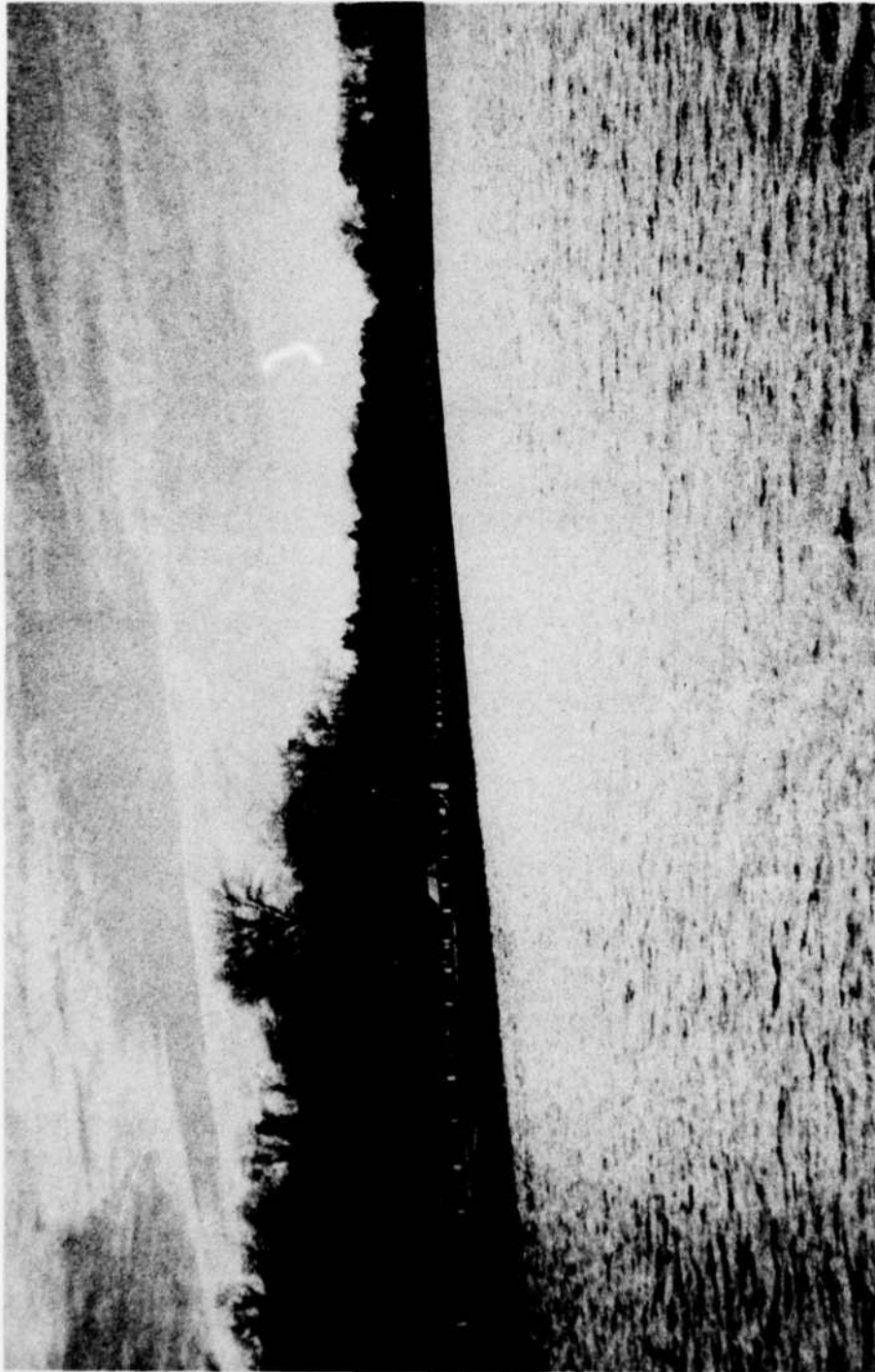
ASSESSMENT OF
GENERAL CONDITIONS

Malaga Dam is assessed to be in an overall structurally good condition and is recommended to be downgraded from a high hazard to a low hazard category. Overtopping of the highway crossing the dam would not significantly increase the danger of loss of life or property damage as the downstream flood plain is uninhabited. No detrimental findings were uncovered to render a significantly hazardous assessment. Remedial actions recommended to be undertaken in the future are 1) regrade and protect the downstream embankment areas at the bridge wingwalls, 2) construct slope paving on the downstream backslopes south of the roadway profile low points and 3) remove trees and major root systems on the downstream embankment slopes.

This dam has an inadequate spillway capacity, being able to accommodate only 16% of the design flood.


F. Keith Jolls P.E.
Project Manager





OVERVIEW OF MALAGA DAM

DECEMBER 1978

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PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
NAME OF DAM MALAGA DAM FED. ID# NJ 00443

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority

This report is authorized by the Dam Inspection Act, Public Law 92-367, and has been prepared in accordance with Contract FPM-36 between Louis Berger & Associates, Inc. and the State of New Jersey and its Department of Environmental Protection, Division of Water Resources. The State, in turn, is under agreement with the U.S. Army Engineer District, Philadelphia, to have this inspection performed.

b. Purpose of Inspection

The purpose of this inspection is to evaluate the structural and hydraulic condition of the Malaga Dam and appurtenant structures, and to determine if the dam constitutes a hazard to human life or property.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances

Malaga Dam is an old (100+ years) earth highway embankment approximately 1525 feet in length with a 50 year-old concrete bridge and spillway located about 300 feet from the easterly end. The highway embankment carries the Harding Highway (Route 40) across the entire south shore of Malaga Lake and forms the dam structure. It is believed an older dam embankment predated the 1929 highway construction. The spillway structure is roughly 22 feet wide and consists of three sections of timber flashboards which form a permanent weir. The entire upstream face of the embankment is protected by an ancient timber-piled bulkhead.

b. Location

Malaga Dam is located on State Highway 40, Franklin Township, Gloucester County and is built across Scotland Run 0.3 mile west of the intersection of State Highways 40 and 47.

c. Size Classification

The maximum height of the dam is 17.8 feet at the spillway and the maximum storage is estimated to be 1460 acre feet. Therefore, the dam is placed in the intermediate size category as defined by the Recommended Guidelines for Safety Inspection of Dams.

d. Hazard Classification

Based on the Corps of Engineers criteria and the fact that in the event of a failure, little damage would be inflicted on downstream property or endanger any lives, the classification of the dam is downgraded to low hazard as a failure would cause minimal damage except to the dam itself. The road approaches to each side of the dam are straight and level and afford ample sight distance to preclude anyone accidentally driving onto the overtopped roadway. Immediately downstream of the dam, the few adjacent residences are situated well above flood elevation and much of the high water would be substantially dissipated before reaching the Willow Grove dam which is 1.8 miles downstream.

e. Ownership

According to Division of Water Resources records, the dam is owned by Franklin Township. However, NJDOT, under several programs of Right-of-Way acquisition over many years, now own portions, but not all, of the spillway structure.

f. Purpose of Dam

The dam presently impounds a recreation lake. However, an old flour mill and earlier dam existed at the site prior to the highway construction (no evidence of the old mill exists).

g. Design and Construction History

The dam was reconstructed by the State Highway Department in 1929 as part of the roadway embankment for what was then designated State Route 48. The typical design section of the reconstruction indicated a top width of 40 feet with graded side slopes of 1.5 to 1. An 8" thick reinforced concrete pavement runs along the entire crest length of the dam with asphalt resurfacing on the bridge and various portions of the two lane roadway. The road work was built over an earlier dam embankment, the timber bulkhead on the upstream face already being in place prior to 1929. The timber sheeting exists all along the upstream side of the dam and is supported by 12" vertical piling spaced at 6 feet centers. The dam was overtopped in 1940 and minor damage was repaired on the downstream slopes which were partially scoured out.

h. Normal Operating Procedures

At the present time, there are no specific operating procedures at this site except periodic maintenance of the roadway and appurtenant structures. See Section 4.

1.3 PERTINENT DATA

a. Drainage Area

The drainage area of Malaga Dam is 29.1 square miles.

b. Discharge at Dam Site

The spillway capacity with the reservoir at the dam crest elevation is calculated to be approximately 500 cfs. No discharge records are available at this site.

c. Elevation (Above M.S.L.)

Top of dam - 88.5 (Average of lower areas in roadway pavement)

Recreation Pool - 84.8
Streambed at Center Line of Dam - 70.7

d. Reservoir

Length of Recreation Pool - 4300 feet
Length of Maximum Pool - 6000 feet

e. Storage

Recreation Pool - 800 acre-ft.
Top of dam - 1460 acre-ft.

f. Reservoir Surface

Top of dam - 258 acres
Recreation pool - 100 acres

g. Dam

Type - Earth embankment with concrete spillway
Length - 1525 feet
Height - 21.5 feet (concrete bridge structure)
Freeboard between normal reservoir and top
of dam - 3.7 feet
Top width - 40+ feet
Side slopes - 1½H:1V
Zoning - composition and compactness unknown

h. Diversion and Regulating Tunnel

None

i. Spillway

Type - reinforced concrete frame with timber
flashboards.
Effective length of weir - 22.4 feet
Crest Elevation - 84.8 (flashboards in place)

j. Regulating Outlets

Removable flashboards in all three spillway
sections.
Minimum invert elevation - 78.3 (flashboards
removed)

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

The only design information available for review was the 1929 as-built roadway plans for the construction of the concrete pavement and bridge structure. The work was designed and the construction supervised by the State Highway Department. Additionally, a State Water Policy Commission field report with reference sketches (dated 1941) confirmed the field inspection measurements.

2.2 CONSTRUCTION

No information was available as to who accomplished the 1929 construction or who built the earlier timber bulkhead. Both the 1929 plans and deteriorated condition of the timber indicate that it was constructed at a prior time.

2.3 OPERATION

An inspection report dated 19 December 1941 indicated that the highway was overtopped 1 September 1940 and portions of the downstream embankment near the right abutment were washed out but that no "appreciable damage" was done. The report further indicated that the stop planks cannot be removed. No records of subsequent construction modifications are in evidence and the present structure is essentially as it was originally built.

2.4 EVALUATION

a. Availability

Sufficient engineering data is available except for any specific data relating to the embankment zoning, density or permeability.

b. Adequacy

The original engineering data reviewed indicates that the bridge structure was carefully designed and built in accordance with the design plans.

As the workmanship was supervised by the State Highway Department, it is believed that it was carried out in a proper manner (as evidenced by the satisfactory condition of most of the exposed bridge elements). The available information is therefore deemed to be adequate.

c. Validity

The validity of the available data is not questioned. The lack of borings or subsurface records makes it impossible to render an evaluation regarding the structural condition of the earthwork embankment. Much of the embankment was already in place prior to the 1929 road and bridge work. However, additional information required for future investigation should include:

1. Borings and material classification of the embankment, as well as density and permeability evaluations.
2. Piezometric readings in the embankment.

Based on field observations, the existing engineering data appears valid insofar as the dam's existing configuration. Referring to Section 7 hereinafter, further studies regarding the safety are not recommended; the above investigations are cited merely as basic requirements the owner should consider if future inspections are undertaken at his request.

The underlying foundation soils are recent alluvium overlying stratified swamp deposits. The silty clays and sands are variable in composition with occasional pockets and layers of clay and in general, exhibit poor drainage characteristics.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General

Visual inspections of the dam were conducted on December 5 and 6, 1978. The water level at the time of inspection was a few inches above the timber flashboards and flowing freely. In addition to the inspection, discussions were held with the State Department of Transportation, the Franklin Township Engineer's office and the County Engineer.

b. Dam

In general, the dam was found to be in an old but satisfactorily stable condition. The reservoir water level appears to be fairly constant during most periods (except for heavy rainstorms) and the outflow is fairly uniform. The embankment appears stable and there is little evidence of any seepage although much of the natural ground area below the downstream toe is several feet above the outlet channel invert. There is one area extending 60 to 80 feet to the right of the spillway where considerable seepage was noted. There is ample evidence of various repaving, patching and mudjacking of the roadway pavement which indicates minor subsidence has taken place in the past. However, the position of the guardrail, telephone poles and timber bulkhead indicate that this has been of an inconsequential nature and most probably caused by pumping at the pavement joints. There are many large trees on the downstream embankment and several areas where the surface has sloughed out. However, practically all such areas are stabilized with permanent ground cover. The embankment at the ends of the bridge wingwalls is badly eroded and has been patched and repaired numerous times. The surface runoff from the roadway pavement appears to be a continuing maintenance problem.

The timber bulkhead is very old and numerous areas are rotted and disintegrated beyond repair. The vertical piling appears fairly solid and is in true alignment except for occasional short portions but the sheeting and whaling are in poor condition above grade. There is no evidence as to the depth of the bulkhead or when it was built except it predates the 1929 road construction.

c. Appurtenant Structures

The concrete spillway bridge is in fair condition and the timber flashboards, being constantly submerged appear free of dry rot. However, it would prove difficult to remove them without destroying them. The walls of the bridge abutments and wings are cracked and spalled but are structurally sound insofar as the dam structure is concerned. The tops of the downstream wingwalls are badly cracked and the superstructure soffit is spalled and is undoubtedly in need of replacement or repair. A cursory review of the traffic volume using Route 40 indicates the superstructure should be repaired or more probably, be replaced (if subjected to present FHWA and DOT bridge rating criteria).

d. Reservoir Area

The reservoir has a stable well-defined shoreline and exhibits little silting except possibly at the northerly end. It is clear of major debris. A short portion of new timber bulkhead is presently being constructed immediately upstream from the right abutment but this will have no affect on the dam's stability or hydraulic conditions. It is being installed as perimeter containment for a small recreational facility. The few homes constructed around the reservoir are well above the dam crest elevation.

e. Downstream Channel

The Scotland Run riverbed below the dam passes through a relatively wide low-lying flood plain before it reaches the headwaters of Willow Grove Lake, approximately 1.2 miles to

the south. The homes adjacent to the east edge of the river valley (along Defiance Road , to the south of Route 40) are all well above the flood level and in no danger of being inundated. There is no evidence of extreme high water marks as the low-lying river valley between the two reservoirs is quite heavily wooded and undeveloped.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

Operational procedures were not observed by the inspection team. The roadway embankment and appurtenant structures are part of the District Four Department of Transportation normal operation and maintenance. No manuals or instructions for the regulation of flow were available. The Franklin Township Road Maintenance Department maintain control of the reservoir spillway elevation.

4.2 MAINTENANCE OF DAM

Maintenance of the embankment and bridge structure are carried out by the NJDOT. There is no evidence of any maintenance or repair of the intake structure having been undertaken recently. Further, there is no evidence of maintenance on the timber bulkhead.

4.3 MAINTENANCE OF OPERATING FACILITIES

The only operational facilities are the flashboards on the timber weirs and they apparently have not been pulled in several years.

4.4 DESCRIPTION OF WARNING SYSTEM IN EFFECT

Presently, there is no formal warning system in effect. However, the County Road Supervisor's personnel monitor the dam during periods of heavy flow, as do State DOT maintenance forces through their regular inspections.

4.5 EVALUATION OF OPERATIONAL ADEQUACY

The present operational procedures and safeguards during periods of heavy flow are deemed to be adequate in view of the period of time required for the dam to be overtopped. Township personnel diligently pursue monitoring activities during heavy storms and keep in close contact with State DOT forces.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data

In accordance with the criteria in the Recommended Guidelines for Safety Inspection of Dams, it has been determined that the dam at Malaga Lake is intermediate in size and is placed in the low hazard category. Accordingly, the spillway design flood (SDF) was determined by the inspection team to be one-half the probable maximum flood (PMF). The inflow hydrograph was calculated using precipitation data from Hydrometeorological Report No. 33.

In accordance with Corps of Engineers directives, the inflow hydrograph and flood routing were performed utilizing the HEC-1 computer program. Peak inflow to the reservoir for the $\frac{1}{2}$ PMF was 3095 cfs. When routed through the reservoir, this reduced insignificantly to 3090 cfs. The spillway capacity before overtopping occurs is approximately 500 cfs. Based on this, the spillway will accommodate only 16% of the SDF. This flood would cause overtopping of the dam of approximately 0.7 feet on the average and 2.5 feet at the lowpoint.

b. Experience Data

There are no current streamflow records available for Malaga Lake Dam, although there is a water quality station one mile upstream. However, records show that in 1940, the road was overtopped by approximately one foot. There is no hearsay evidence of recent overtoppings.

c. Visual Observations

Visual inspection indicates that the hydraulic review substantially conforms to the drainage characteristics of this basin.

d. Overtopping Potential

Based on the results of the hydraulic analyses, the capacity of the spillway is inadequate to accommodate the SDF. Because the dam has been overtopped at least once in the past, the potential for overtopping continues to exist although little damage would occur, except to the dam itself.

e. Drawdown

At the present time drawdown is not immediately possible as there is no easy method of removing all the stop planks. However, if in an emergency the stop planks were removed by force, the lake would take approximately two days to drawdown from normal pool elevation (84.8) to the base of the stop planks (78.3). There are no provisions to further dewater the lake.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations

Based on existing conditions inspected in the field and the review of the 1929 single source of construction plans, the dam is in relatively good condition except for the deterioration of the upstream timber bulkhead and the bridge superstructure. Although no safety hazard is foreseen due to the condition of the timber sheeting, a collapse of the bridge superstructure due to vehicular traffic could block the discharge channel and create a hydraulic restriction.

The embankment width is excessively wide in relation to its average height (10+ feet) and accordingly, the structural stability is felt to be satisfactory as no evidence of major seepage was observed. However, several small drainage channels have been built into a private lawn area immediately below the left abutment. This indicates that there is a drainage problem here which could be caused by a roadway catch basin on the south curb which drains back into the reservoir. Conceivably this catch basin leaks to the south during periods of high water (and reverse flow).

b. Design and Construction Data

Although no design computations for the concrete bridge were available, it is conservatively designed and was erected in accordance with the contract plans. Its stability, in spite of its age, is not questioned insofar as the hydraulic elements are concerned. Moreover, there is little evidence of any major modifications since the original installation.

c. Operating Records

No records are available but the sluiceway operates satisfactorily. The only known instance of the

roadway being overtopped was the flooding in September of 1940, at which time, no appreciable damage was suffered (according to the damage report). However, from inspection of a photograph taken at that time, a considerable portion of the roadway shoulder was washed out.

d. Post Construction Changes

The only post construction changes in evidence are minor modifications to the highway guardrail, signing elements and curb inlets. None of these adversely affect the integrity of the dam except for the road surface drainage which has caused erosion at the ends of the bridge wingwalls. As previously stated, the roadway surface drainage appears to be a continual maintenance problem.

e. Seismic Stability

The dam is located in Zone 1 and due to its geometry and foundation, experience indicates that this dam would have adequate stability under dynamic loading conditions as it is very stable under static loadings.

SECTION 7 - ASSESSMENTS/RECOMMENDATIONS/
PROPOSED REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Subject to the inherent limitations of the Phase I visual inspection, the Malaga Dam is classified as being in a sound and satisfactory structural condition although the spillway is incapable of passing the design flood. The dam embankment was built of unknown composition but due to its width to height ratio and lack of any visible evidence of seepage, is felt to be of a sufficient impervious condition to withstand normal hydraulic heads. A great portion of this embankment is believed to be over 100 years old. The present spillway capacity is inadequate and does not meet the requirements of the Recommended Guidelines for Safety Inspection of Dams, being able to accommodate only 16% of the design flood as calculated by Corps of Engineers criteria. However, the calculated SDF would overtop the dam by only slightly more than 2 feet at the low points along the top of dam and except for the probable erosion of the downstream face, it is felt that little other damage would occur.

b. Adequacy of Information

The information gathered for the Phase I inspection is deemed to be adequate regarding the structural stability of the dam. However, no recent surveys have been made and recorded performance information is believed to be non-existent except for the 1940 overtopping.

c. Urgency

No urgency is attached to implementing further studies except for the bridge superstructure where the vehicular traffic capacity is suspect. It is recommended that the remedial measures enumerated below be taken under advisement in the future.

d. Necessity for Further Study

Due to the low hazard classification of the dam and the fact that little property damage is foreseen in case of a failure, further engineering studies under the purview of P.L. 92-367 are deemed unnecessary.

7.2 RECOMMENDATIONS/REMEDIAL MEASURES

The attached calculations indicate that the spillway does not meet the requirements of the recommended guidelines, being able to accommodate only 16% of the design flood. Any overtopping will initially be concentrated at two low points in the undulating roadway profile.

a. Alternatives

On the basis of visual inspection, improvements to the present spillway are not warranted. However, the downstream face of the embankment at the extreme low point in the roadway profile (roughly 500 feet to the west of the spillway) could be further protected with riprap or slope paving and in effect, act as an auxiliary spillway should overtopping occur. Additionally, the embankment areas at the ends of the bridge wingwalls on the south side should be regraded and protected with concrete or asphalt slope protection.

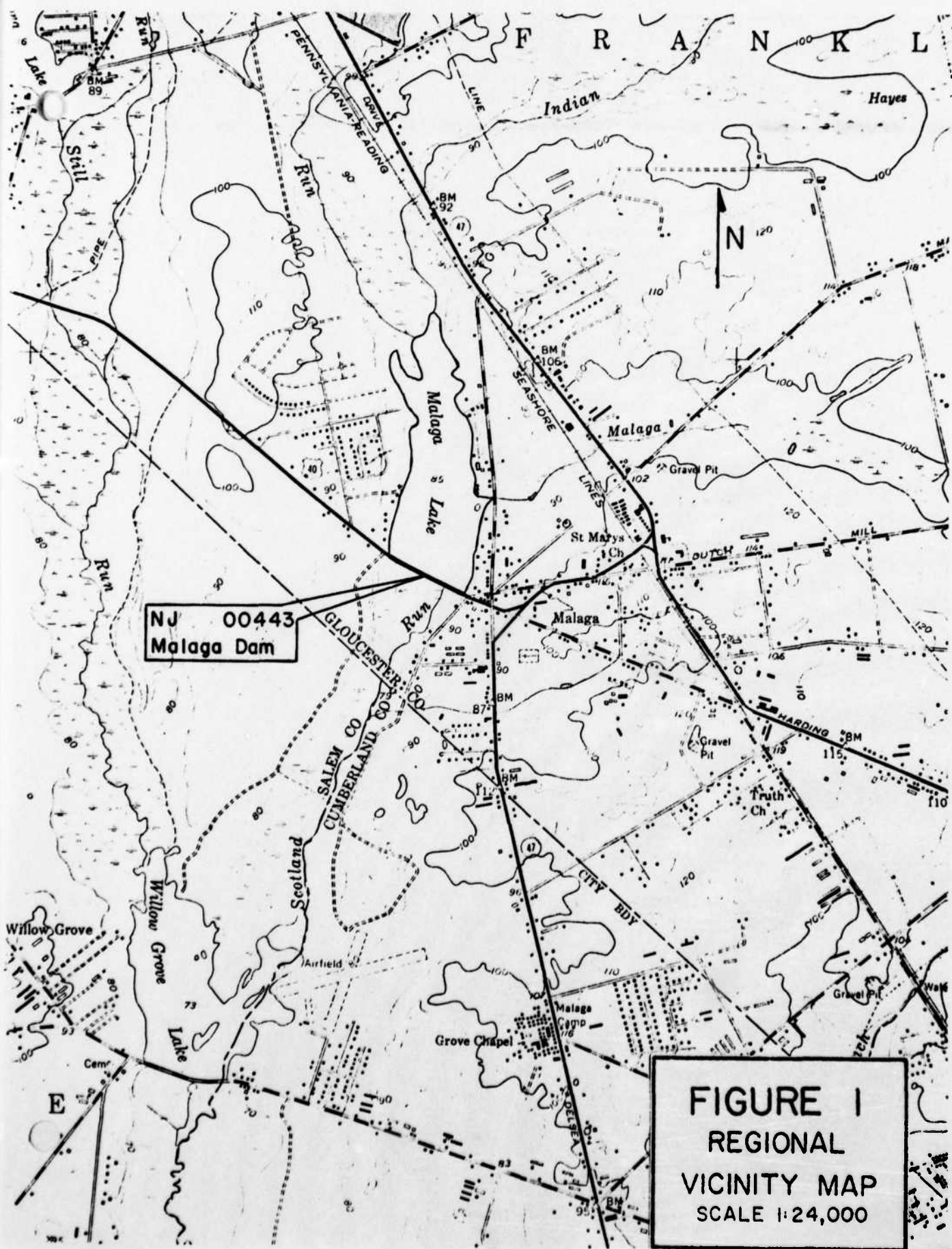
Other remedial measures to be taken under advisement include:

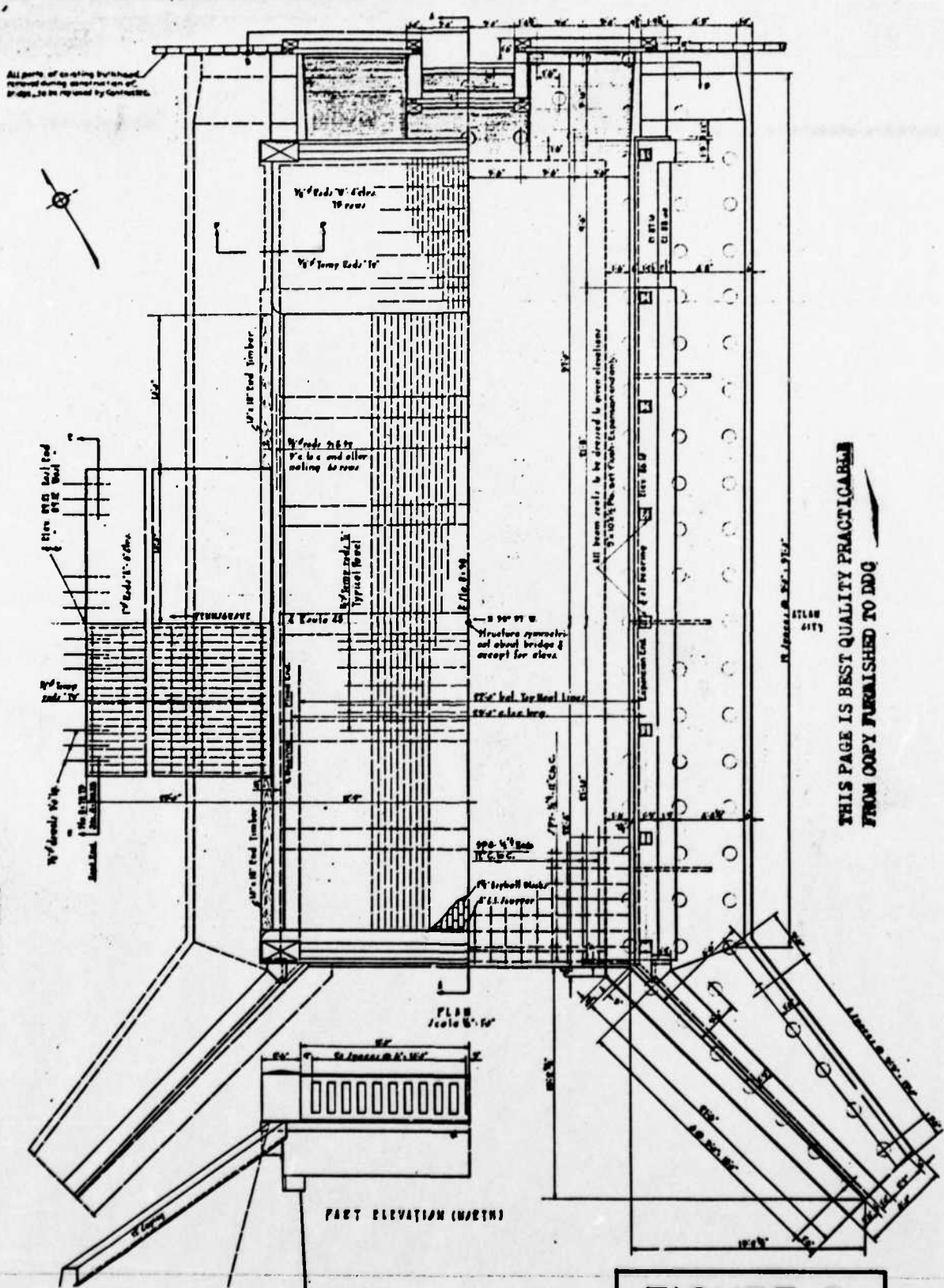
- 1) removal of the trees and major root systems on the downstream embankment to lessen the piping potential
- 2) rebuild the deteriorated timber bulkhead at some future time.

However, the cost of these remedial measures should only be considered after completion of further design and economic studies (e.g. placing a riprap blanket against the timber bulkhead might be a more economical solution than replacement in kind.)

b. O&M Maintenance and Procedures

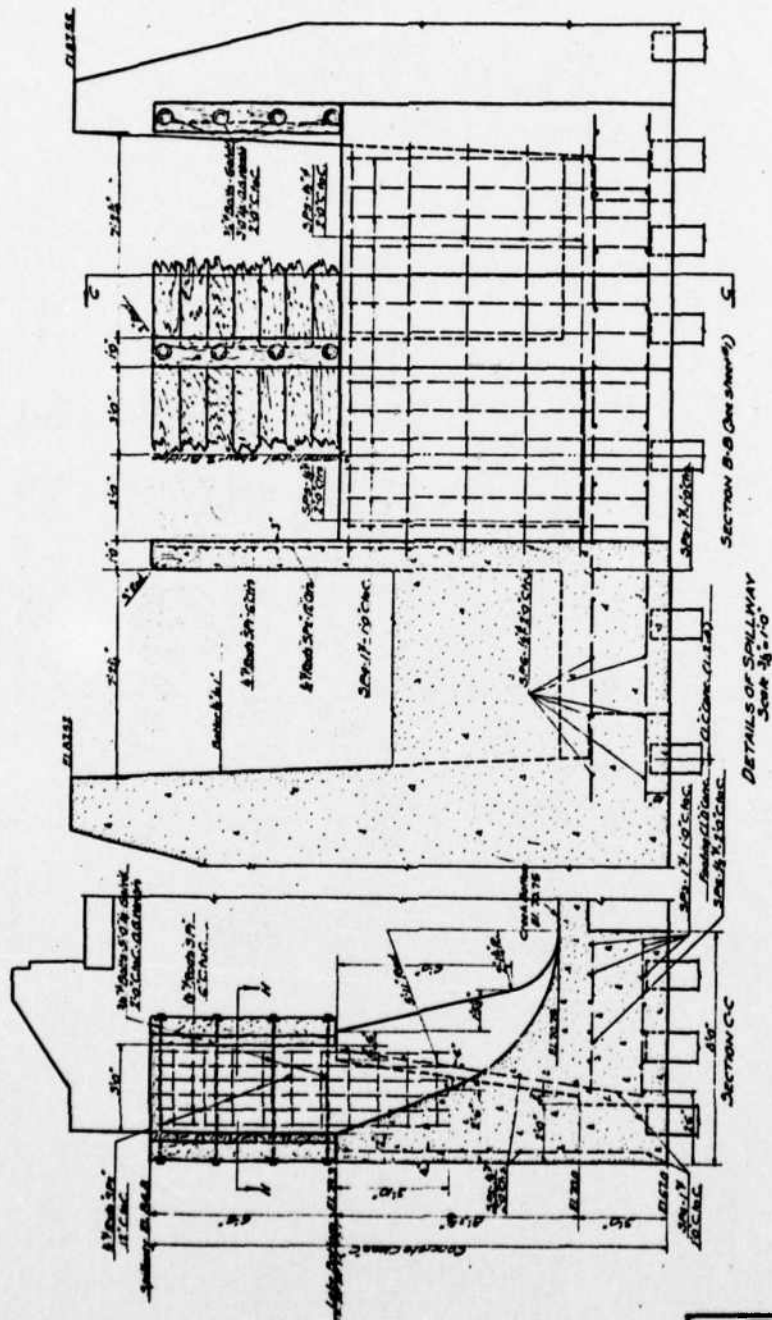
No additional procedures other than those presently in effect appear to be warranted in view of the above assessment.





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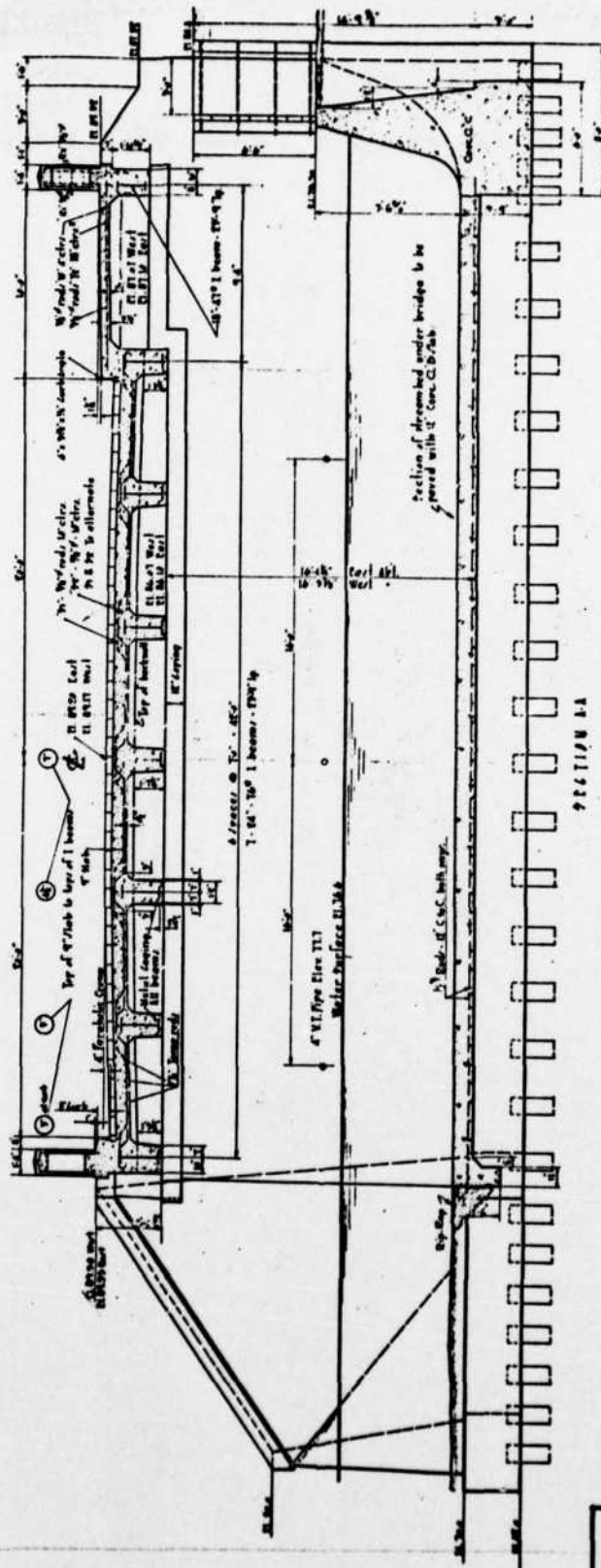
FIGURE 2
PLAN OF
BRIDGE & SPILLWAY



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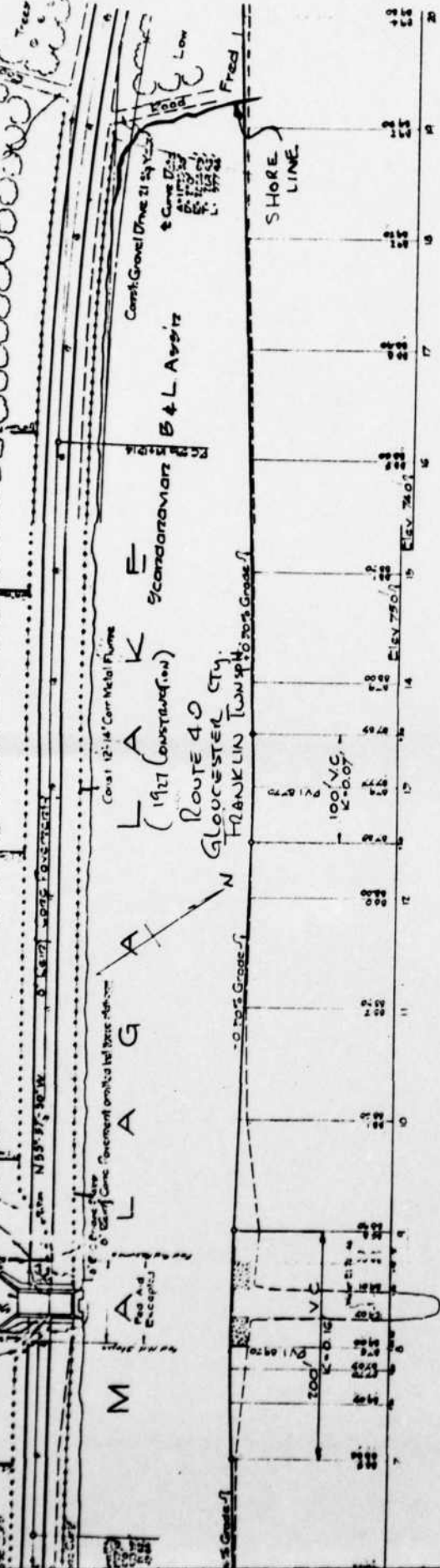
FIGURE 3

DETAILS OF
SPILLWAY



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FIGURE 4
BRIDGE
SECTION



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FIGURE 5
GENERAL PLAN
OF DAM

Check List
Visual Inspection
Phase 1

Name Dam Malaga County Gloucester State N.J. Coordinators NJDEP

Date(s) Inspection 5 Dec 78 Weather Clear Temperature 40°

Pool Elevation at Time of Inspection 85+ M.S.L. Tailwater at Time of Inspection 74+ M.S.L.

Inspection Personnel:

K. Jolls _____
R. Lang _____
M. Carter _____

K. Jolls _____ Recorder

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SEE PAGE ON LEAKAGE		No evidence of seepage observed beyond bridge abutments.
STRUCTURE TO BUTTMENT/EMBANKMENT JUNCTIONS	Satisfactory condition.	Junction very ill-defined. Hgt. of embankment very low (3'4") at ends.
RAINS	Roadway has several curb drop-inlets.	Drain at left abutment passes under road (back into reservoir)
WATER PASSAGES	None	
FOUNDATION	Sand/gravel. Bridge structure on timber piling.	

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	Numerous cracks and spalling in concrete structure.	bridge deck-asphalt block wearing course
STRUCTURAL CRACKING	Tops of wingwalls badly cracked. Major elements structurally sound.	Repairs required.
VERTICAL AND HORIZONTAL ALIGNMENT	Satisfactory.	Bridge approaches have settled and be repaved in past. Condition appears stable.
MONOLITH JOINTS	Satisfactory.	
CONSTRUCTION JOINTS	Satisfactory. Some minor spalling.	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
FACE CRACKS	Numerous pavement failure in roadway surface. Areas mud-jacked	Mud jacking indicates settlements.
USUAL MOVEMENT OR JACKING AT OR BEYOND THE TOE	Upstream embankment enclosed by timber bulkhead.	Bulkhead was in place when roadway file was placed.
OUCHING OR EROSION OF BANKMENT AND ABUTMENT OPES	Exosion observed at bridge wingwalls.	Many large trees on downstream side-slopes
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	Satisfactory.	Roadway elevation varies across dam by several feet.
RIPRAP FAILURES	No riprap	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
FUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	12"φ timber piling on upstream bulkhead and 4" planking in poor condition.	New bulkhead under construction at right abut. along upstream shore (recreation area).
ANY NOTICEABLE SEEPAGE	Satisfactory	Embankment was built at earlier date than bridge (1928).
TAFF GAGE AND RECORDER	None	Downstream embankment stabilized by ground cover.
DRAINS	Roadway curb drains. Some gullies exist on downstream embankment face.	

OUTLET WORKS

VISUAL EXAMINATION OF CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
	No outlet condit. except bridge invert opening. ↑	
INTAKE STRUCTURE	Wood flash boards- good condition.	timber has been replaced in last few years.
OUTLET STRUCTURE	Paved concrete invert through bridge.	Good condition. Minor cracking.
OUTLET CHANNEL	Natural stream channel.	
EMERGENCY GATE	None	

UNCATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	3 section wier thru bridge (see Road Plans)	
APPROACH CHANNEL	None	
DISCHARGE CHANNEL	Natural Stream bed beyond bridge.	
BRIDGE AND PIERS	See previous page.	

GATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	None.	
APPROACH CHANNEL		
DISCHARGE CHANNEL		
BRIDGE AND PIERS		
GATES AND OPERATION EQUIPMENT		

INSTRUMENTATION

VISUAL EXAMINATION MONUMENTATION/SURVEYS	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
	None	
OBSERVATION WELLS	None	
WEIRS	None	
PIEZOMETERS	None	
OTHER		

RESERVOIR

VISUAL EXAMINATION OF

OBSERVATIONS

REMARKS OR RECOMMENDATIONS

SLOPES

Very flat.

Clear. No debris

Banks well-defined & stabilized. Appears to be only minor fluctuation in normal reservoir depth.

SEDIMENTATION

Unknown. Conditions observed at bulkhead indicates only minor sedimentation.

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
-----------------------	--------------	----------------------------

CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	No obstructions	Flood plain heavily wooded over.
--	-----------------	-------------------------------------

SLOPES

Very flat flood plain
several hundred feet wide.

APPROXIMATE NO.
OF HOMES AND
POPULATION

10 (30)
All homes on easterly
bluff above flood plain elevation.

Flooding does
not appear
to be a
danger.

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

ITEM	REMARKS
PLAN OF DAM	Available (1928 Road Construction Plans)
REGIONAL VICINITY MAP	Available
CONSTRUCTION HISTORY	Unknown.
TYPICAL SECTIONS OF DAM	Available.
HYDROLOGIC/HYDRAULIC DATA	Unavailable.
OUTLETS - PLAN	Available.
- DETAILS	"
- CONSTRAINTS	"
- DISCHARGE RATINGS	
WATERFALL/RESERVOIR RECORDS	Unavailable

ITEM	REMARKS
DESIGN REPORTS	None
GEOLOGY REPORTS	None
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	None Available
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	None Available
POST-CONSTRUCTION SURVEYS OF DAM	None
BORROW SOURCES.	Unknown

ITEM	REMARKS
MONITORING SYSTEMS	Unknown.
MODIFICATIONS	None
HIGH POOL RECORDS	Unavailable.
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	Unknown
MAINTENANCE OPERATION RECORDS	Unknown

ITEM	REMARKS
------	---------

SPILLWAY PLAN

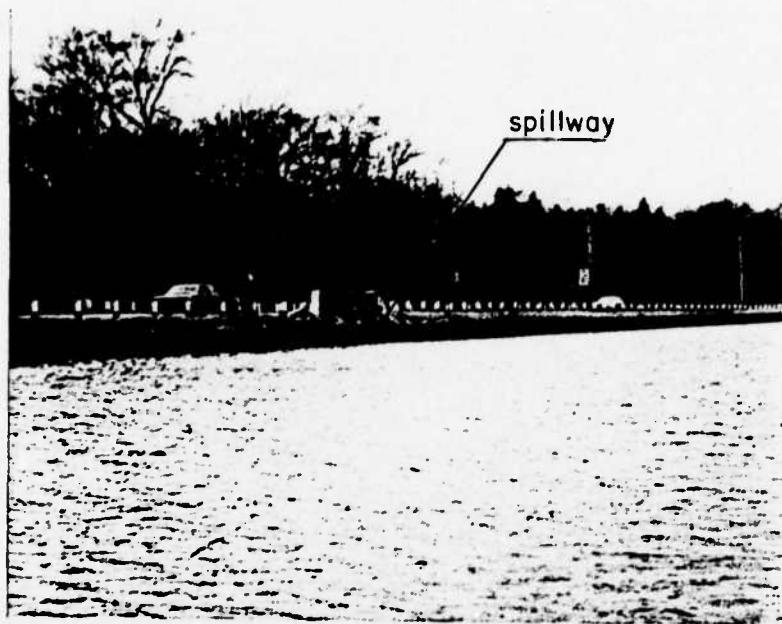
SECTIONS

DETAILS

Available.

OPERATING EQUIPMENT
PLANS & DETAILS

None.



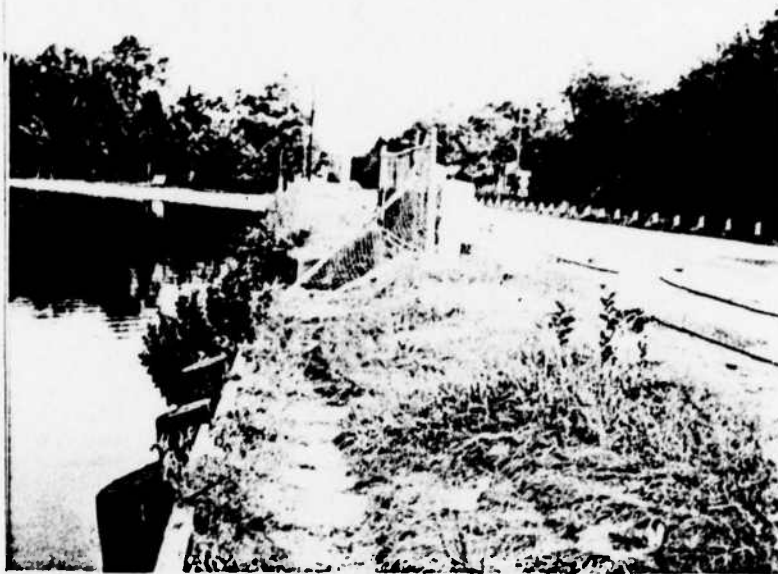
View Southwest along dam

December 1978



Downstream channel

December 1978



View East along dam

December 1978



Downstream view of East abutment

December 1978



Timber sheeting on North side of dam

December 1978



Downstream view of bridge and spillway

December 1978

CHECK LIST
HYDROLOGIC AND HYDRAULIC DATA
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: 29.1 Sq. Mi.

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 84.8 (800 AF)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): 88.5 (1460 AF)

ELEVATION MAXIMUM DESIGN POOL: 88.5

ELEVATION TOP DAM: 88.5

CREST: _____

- a. Elevation 84.8
- b. Type Narrow Crest Weir
- c. Width 1.0'
- d. Length 20'
- e. Location Spillover beneath Concrete bridge
- f. Number and Type of Gates None

OUTLET WORKS: _____

- a. Type None
- b. Location _____
- c. Entrance inverts _____
- d. Exit inverts 70.75 (Stream bed)
- e. Emergency draindown facilities None

HYDROMETEOROLOGICAL GAGES: None

- a. Type _____
- b. Location _____
- c. Records _____

MAXIMUM NON-DAMAGING DISCHARGE: 500⁺ cfs

BY D.J.M. DATE 12-78

LOUIS BERGER & ASSOCIATES INC.

SHEET NO. A.1 OF

CHKD. BY DATE

MALAGA LAKE DAM INSPECTION

PROJECT C 226

SUBJECT

Precipitation & Unitgraph data for

HEC-1

Precipitation

Rainfall losses assumed:

Initial loss = 0.5"

loss rate = 0.1"/hour

drainage area = 29.1 sq miles

PMP for 24 hours duration @ 200 sq miles
= 24.5"

Max	6	hour	percentage	≈	102 %
"	12	"	"		112 %
"	24	"	"		122 %
"	48	"	"		132 %

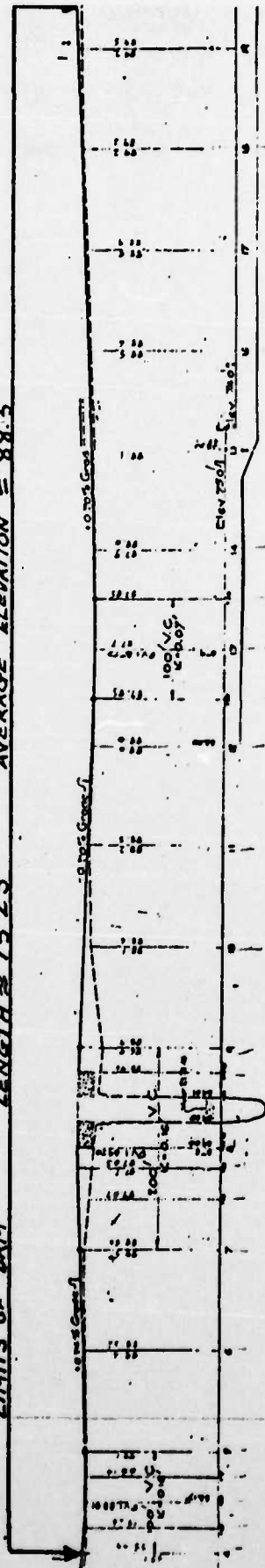
SNYDER COEFFICIENTS (OBTAINED FROM CORPS OF ENGINEERS)

T_p = 31 hours

C_p = 0.43

MALAGA LAKE DAM

LIMITS OF DAM LENGTH $\approx 1525'$ AVERAGE ELEVATION $\approx 88.5'$



SPILLWAY CREST ≈ 84.8 LAKE DEPTH $\approx 8.0'$

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BY D.J.M. DATE 12-78

LOUIS BERGER & ASSOCIATES INC.

SHEET NO. A3 OF CHKD. BY DATE MALAGA LAKE DAM INSPECTIONPROJECT C226SUBJECT Spillway discharge

Top of spillway Elev. = 84.8'

Average top of dam Elev. \approx 88.5'

Over Spillway Crest L = 22.4'			Over Dam L = 1525'			Σ Q
H	C	Q	H	C	Q	
1.0	3.1	69				69
2.0	3.1	196				196
3.0	3.1	361				361
4.0	3.1	556	0.3	2.8	702	1258
5.0	3.1	776	1.3	2.8	6329	7105
6.0	3.1	1021	2.3	2.8	14894	15915
7.0	3.1	1286	3.3	2.8	25598	26884
3.8	3.1	514	0.1	2.8	135	649

0.1' over dam

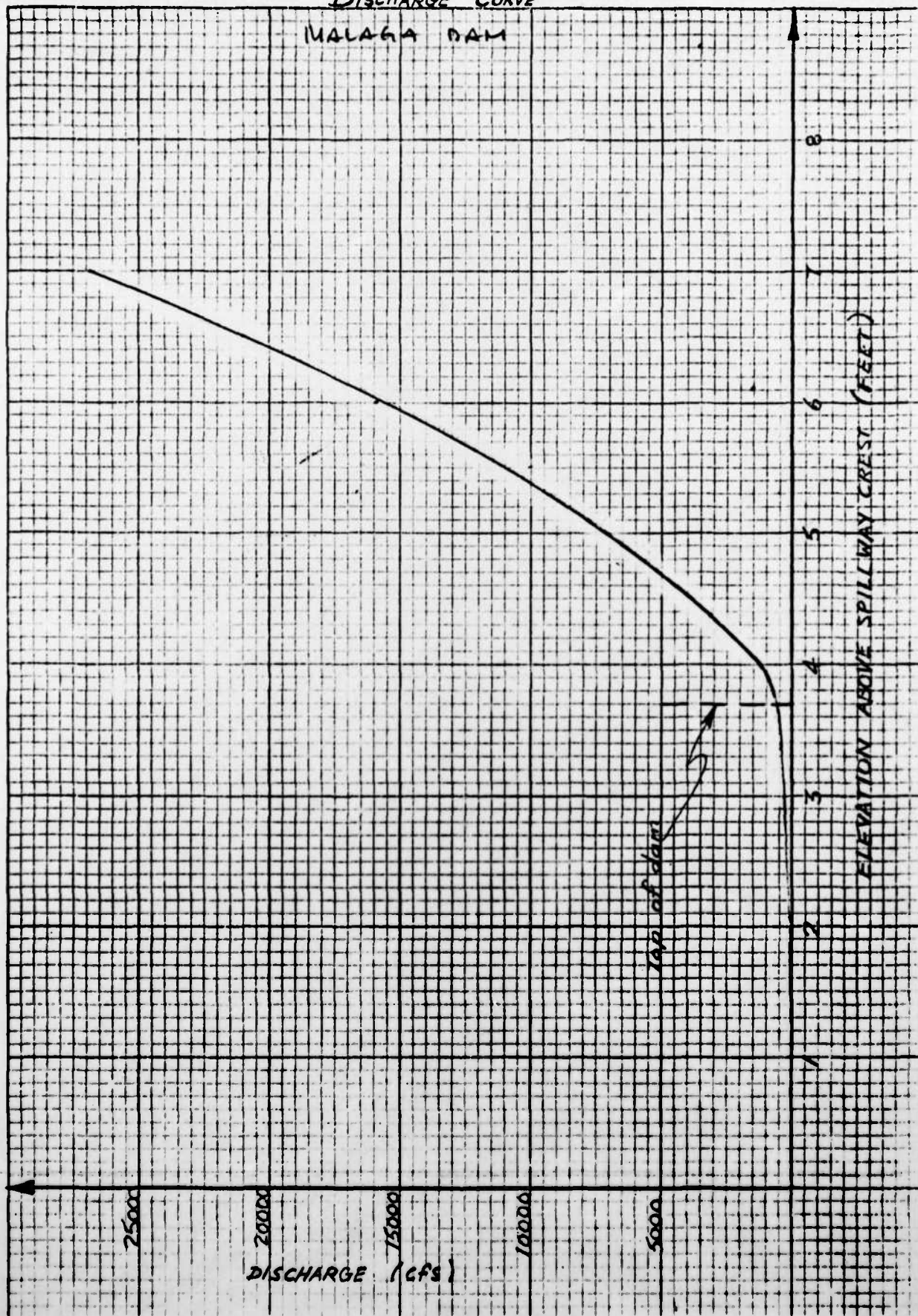
For profile of dam see page 2

46 0707

K-E 10 X 10 TO THE INCH
7 1/2 X 10 IN. ALUMINUM
SCOTT & BOWEN CO.

DISCHARGE CURVE
MALAGA DAM

A 4



BY D.J.M. DATE 12-78

LOUIS BERGER & ASSOCIATES INC.

SHEET NO. A5 OF

CHKD. BY DATE

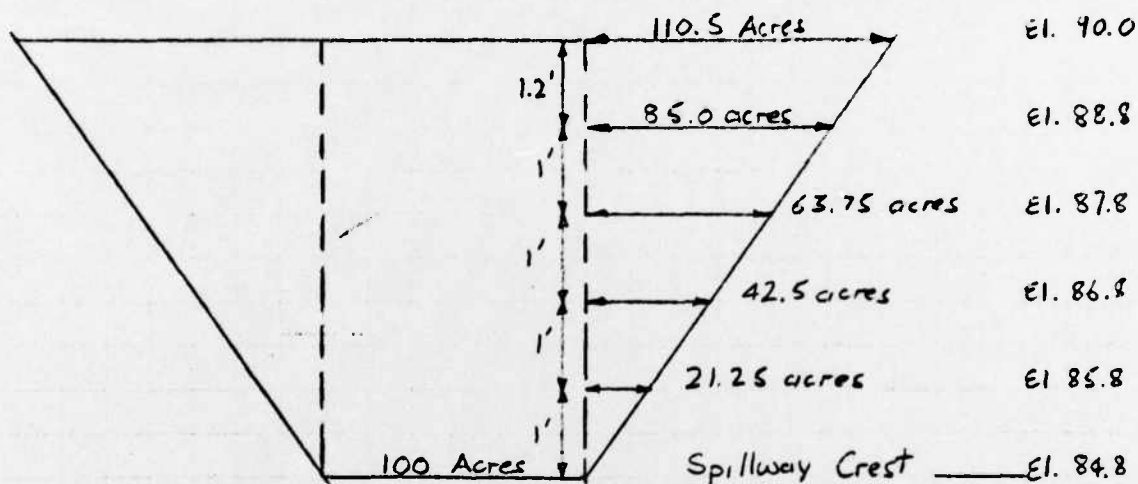
MALAGA LAKE DAM INSPECTION

PROJECT C226

SUBJECT STORAGE CAPACITY

LAKE EL. $\approx 84.8 \pm$ AREA ≈ 100 Acres

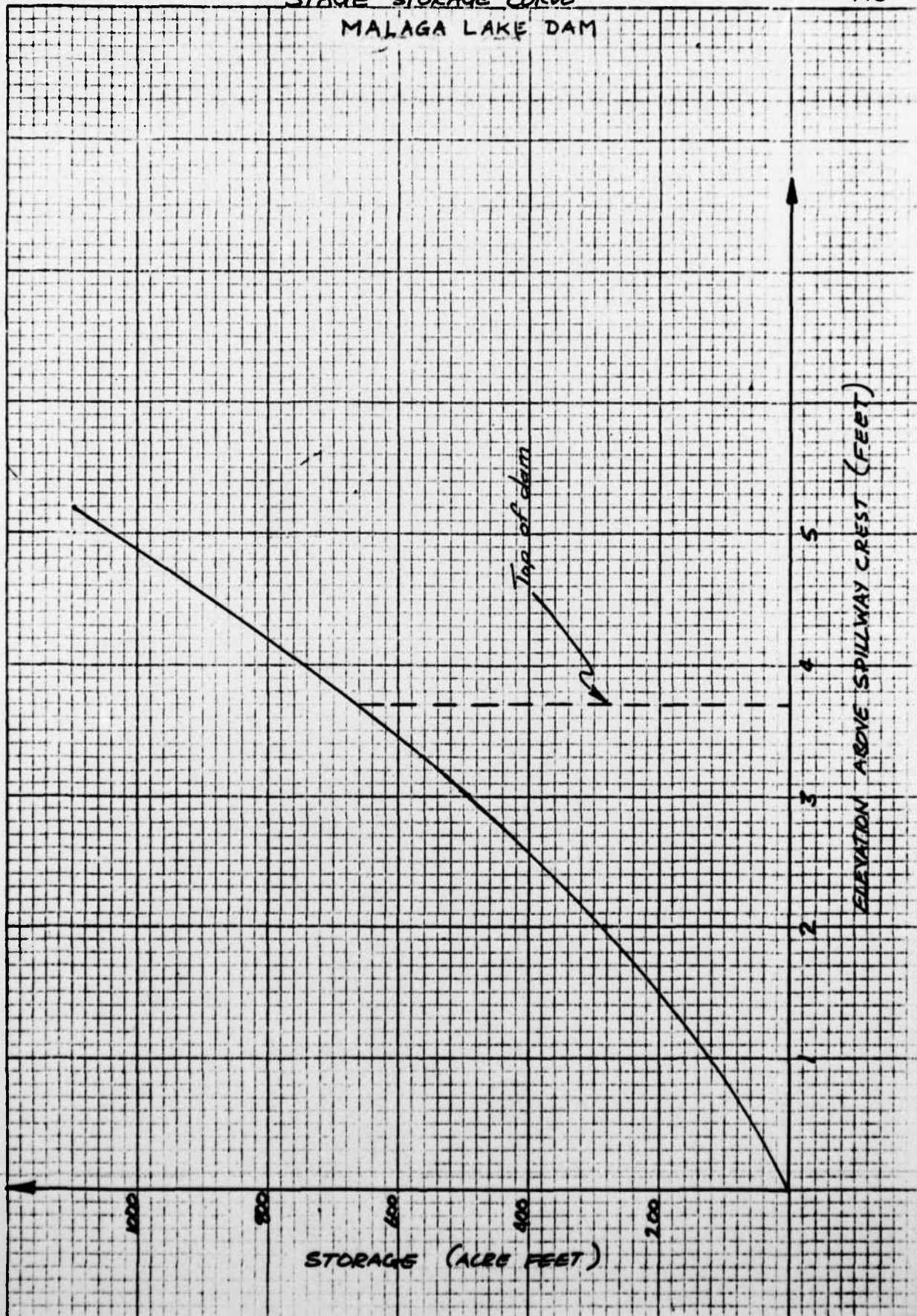
@ EL. 90 AREA ≈ 321 Acres



Elev. Above Crest ft.	Δ Storage Acre ft.
1	121.25
2	285.00
3	491.25
4	740.00
5.2	1095.00

STAGE STORAGE CURVE MALAGA LAKE DAM

A6



46 0707

K-E 10 X 10 TO THE INCH
7 X 10 IN. - ALBANY
KEUPPEL & ESSER CO.

BY D.J.M. DATE 12-78

LOUIS BERGER & ASSOCIATES INC.

SHEET NO. A.7 OF CHKD. BY DATE MALAGA LAKE DAM INSPECTIONPROJECT C.22.6SUBJECT Summary of storage/discharge for HEC-1

<u>Height</u> <u>above crest</u>	<u>storage</u>	<u>discharge</u>
1.0	121	69
2.0	285	196
3.0	491	361
3.8	690	649
4.0	740	1258
4.5	880	3900
5.0	1031	7105
5.5	1193	11000
6.0	1365	15915
6.5	1548	21000

From 4.5' - 6.5' above crest storage assumed to increase
as calculated for that below

BY D.J.M. DATE 12-78

LOUIS BERGER & ASSOCIATES INC.

SHEET NO. A8 OF ...

CHKD. BY ... DATE ...

MALAGA LAKE DAM INSPECTION

PROJECT C226

SUBJECT ...

DRAWDOWN CALCULATIONS

Drawdown calculations assuming stop planks can be removed.

$L \approx 22.4'$ $C \approx 3$ at top to 2.7 at bottom

El. of bottom = $78.3 \pm$ Surface of lake = 84.8
 $\Delta H = 6.5'$

assume area of lake remains constant @ 100 acres

El. $84.8 \rightarrow 82.8$

$H = 5.5$ $C = 3$ $L = 22.4'$ $Q = 867$

Vol of lake = $200 \text{ acre feet} \times 43560 = \text{ft}^3 \div 867 = \text{time (secs)}$
 $= 2.79 \text{ hrs}$

El. $82.8 \rightarrow 80.2$

$H = 3.5$ $C = 2.9$ $L = 22.4'$ $Q \approx 425$

Vol of lake = $200 \times 43560 (\text{ft}^3) \div 425 = \text{time (secs)}$
 $= 5.69 \text{ hrs}$

EL $80.2 \rightarrow 78.3$

$H = 1.25'$ $C = 2.7$ $L = 22.4'$ $Q = 85$

Vol of lake = $250 \times 43560 (\text{ft}^3) \div 85 = \text{time (secs)}$
 $= 35.59 \text{ hrs}$

$\Sigma \text{ time} \approx 44.1 \text{ hrs} \approx 2 \text{ days}$

Calculations assume no inflow to the reservoir

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BY DJM DATE _____
 CHKD. BY _____ DATE _____
 SUBJECT _____

LOUIS BERGER & ASSOCIATES INC.
MALAGA DAM

SHEET NO. 19 OF _____
 PROJECT _____

MALAGA DAM INSPECTION SOUTH GROUP C226
 BY D.J. MULLIGAN
 DECEMBER 1978

JOH SPECIFICATION
 NO NHR NMN IDAY IMR IMIN MEIRC IPLT IPRT NSTAN
 150 1 0 0 0 0 0 0 0 0
 JOPER MNT
 3 0

SUR-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH FOR ONE HALF PMF

ISTAO ICMP IECON ITAPF JPLT JPRT INAME
 1 0 0 0 0 0 1

HYDROGRAPH DATA
 IHYOG IUNG YAREA SNAP TRSCA TRSFC RATIO ISNOW ISAME LOCAL
 1 1 29.10 0.0 0.0 0.0 0.500 0 0 0

PRECIP DATA

SPFE PMS R6 R12 R24 R48 R72 R96
 0.0 24.50 102.00 112.00 122.00 132.00 0.0 0.0

TRSCA COMPUTED BY THE PROGRAM IS 3.634

LOSS DATA

STAKR ELTRP RTIOL EPAIN STRKS RTYOK STRYL CNSTL ALSRX RTINF
 0.0 0.0 1.00 0.0 0.0 1.00 0.50 0.10 0.0 0.0

UNIT HYDROGRAPH DATA

TP= 31.00 CP=0.43 NTA= 0

RECESSION DATA

STRIO= 0.0 ORCSN= 0.0 RTIOR= 1.00

CLARK DID NOT CONVERSE TO GIVEN SNYDER COEFFICIENTS
 APPROXIMATE CLARK COEFFICIENTS FROM GIVEN SNYDER CP AND TP ARE TC=31.59 AND K=52.06 INTERVALS

UNIT HYDROGRAPH 100 END-OF-PERIOD ORIGINATES, LAG= 31.21 HOURS, CP= 0.43 VOL= 0.80

TIME	RAIN	EXCS	COMP
1.	11.	18.	27.
2.	103.	129.	142.
3.	227.	244.	251.
4.	271.	264.	250.
5.	227.	218.	210.
6.	187.	184.	177.
7.	154.	147.	143.
8.	127.	123.	118.
9.	105.	103.	97.
10.	87.	85.	80.
11.	78.	76.	75.
12.	207.	195.	183.
13.	271.	269.	266.
14.	231.	236.	240.
15.	191.	194.	198.
16.	157.	160.	164.
17.	136.	132.	135.
18.	107.	109.	111.
19.	88.	90.	92.
20.	73.	74.	76.

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BY D.J.M. DATE _____

CHKD. BY _____ DATE _____

SUBJECT _____

LOUIS BERGER & ASSOCIATES INC.

MALAGA DAM

SHEET NO A10 OF _____

PROJECT _____

1	0.01	0.00	0.
2	0.01	0.00	0.
3	0.01	0.00	0.
4	0.01	0.00	0.
5	0.01	0.00	0.
6	0.01	0.00	0.
7	0.03	0.00	0.
8	0.03	0.00	0.
9	0.03	0.00	0.
10	0.03	0.00	0.
11	0.03	0.00	0.
12	0.03	0.00	0.
13	0.17	0.00	0.
14	0.21	0.06	0.
15	0.26	0.16	1.
16	0.65	0.55	2.
17	0.24	0.14	6.
18	0.19	0.09	11.
19	0.02	0.00	18.
20	0.02	0.00	26.
21	0.02	0.00	35.
22	0.02	0.00	45.
23	0.02	0.00	55.
24	0.02	0.00	66.
25	0.14	0.04	77.
26	0.14	0.04	89.
27	0.14	0.04	102.
28	0.14	0.04	115.
29	0.14	0.04	129.
30	0.14	0.04	144.
31	0.34	0.24	159.
32	0.34	0.24	176.
33	0.34	0.24	193.
34	0.34	0.24	212.
35	0.34	0.24	232.
36	0.34	0.24	254.
37	2.09	1.99	279.
38	2.50	2.40	314.
39	3.13	3.03	364.
40	7.92	7.82	440.
41	2.92	2.82	551.
42	2.29	2.19	694.
43	0.20	0.10	865.
44	0.20	0.10	1057.
45	0.20	0.10	1267.
46	0.20	0.10	1490.
47	0.20	0.10	1726.
48	0.20	0.10	1973.
49	0.0	0.0	2230.
50	0.0	0.0	2496.
51	0.0	0.0	2770.
52	0.0	0.0	3052.
53	0.0	0.0	3339.
54	0.0	0.0	3628.
55	0.0	0.0	3918.
56	0.0	0.0	4201.
57	0.0	0.0	4472.
58	0.0	0.0	4728.
59	0.0	0.0	4963.
60	0.0	0.0	5184.
61	0.0	0.0	5384.

BY D. J. M. DATE _____

CHKD. BY _____ DATE _____

SUBJECT _____

LOUIS BERGER & ASSOCIATES INC.

MALAGA DAMSHEET NO 111 OF _____

PROJECT _____

62	0.0	0.0	5564.
63	0.0	0.0	5723.
64	0.0	0.0	5861.
65	0.0	0.0	5977.
66	0.0	0.0	6070.
67	0.0	0.0	6139.
68	0.0	0.0	6180.
69	0.0	0.0	6190.
70	0.0	0.0	6168.
71	0.0	0.0	6111.
72	0.0	0.0	6025.
73	0.0	0.0	5924.
74	0.0	0.0	5817.
75	0.0	0.0	5710.
76	0.0	0.0	5604.
77	0.0	0.0	5499.
78	0.0	0.0	5395.
79	0.0	0.0	5293.
80	0.0	0.0	5192.
81	0.0	0.0	5093.
82	0.0	0.0	4996.
83	0.0	0.0	4901.
84	0.0	0.0	4808.
85	0.0	0.0	4717.
86	0.0	0.0	4627.
87	0.0	0.0	4539.
88	0.0	0.0	4452.
89	0.0	0.0	4368.
90	0.0	0.0	4285.
91	0.0	0.0	4203.
92	0.0	0.0	4123.
93	0.0	0.0	4045.
94	0.0	0.0	3968.
95	0.0	0.0	3892.
96	0.0	0.0	3818.
97	0.0	0.0	3746.
98	0.0	0.0	3674.
99	0.0	0.0	3604.
100	0.0	0.0	3536.
101	0.0	0.0	3469.
102	0.0	0.0	3403.
103	0.0	0.0	3338.
104	0.0	0.0	3274.
105	0.0	0.0	3212.
106	0.0	0.0	3151.
107	0.0	0.0	3091.
108	0.0	0.0	3032.
109	0.0	0.0	2974.
110	0.0	0.0	2918.
111	0.0	0.0	2862.
112	0.0	0.0	2808.
113	0.0	0.0	2754.
114	0.0	0.0	2698.
115	0.0	0.0	2635.
116	0.0	0.0	2546.
117	0.0	0.0	2488.
118	0.0	0.0	2434.
119	0.0	0.0	2388.
120	0.0	0.0	2342.
121	0.0	0.0	2298.
122	0.0	0.0	2254.

BY D.J.M. DATE _____
CHKD. BY _____ DATE _____
SUBJECT _____

LOUIS BERGER & ASSOCIATES INC.
MALAGA DAM

SHEET NO A12 OF _____
PROJECT _____

	121	0.0	0.0	0.0	2211.	
	124	0.0	0.0	0.0	2169.	
	125	6.6	7.0	2125.		
	126	6.0	0.0	2082.		
	127	0.0	0.0	2040.		
	128	0.0	0.0	1998.		
	129	6.0	0.0	1958.		
	130	0.0	0.0	1918.		
	131	0.0	0.0	1864.		
	132	0.0	0.0	1812.		
	133	0.0	0.0	1760.		
	134	0.0	0.0	1709.		
	135	0.0	0.0	1655.		
	136	0.0	0.0	1611.		
	137	6.0	0.0	1438.		
	138	0.0	0.0	1238.		
	139	0.0	0.0	998.		
	140	0.0	0.0	419.		
	141	0.0	0.0	207.		
	142	0.0	0.0	48.		
	143	0.0	0.0	40.		
	144	0.0	0.0	31.		
	145	0.0	0.0	23.		
	146	0.0	0.0	15.		
	147	0.0	0.0	8.		
	148	0.0	0.0	0.		
	149	0.0	0.0	0.		
	150	0.0	0.0	0.		
SUM	27.01	23.53	353123.			
	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME	
	6190.	6142.	5669.	4223.	353119.	
CFS		1.96	7.25	16.20	18.81	
INCHES		3048.	11250.	25144.	29198.	
AC-FT						
	7.	0.	0.	0.	0.	0.
	8.	0.	0.	0.	0.	13.
	9.	0.	0.	0.	0.	72.
	10.	22.	39.	45.	51.	13.
	11.	89.	114.	127.	140.	220.
	12.	97.	63.	745.	863.	1248.
	13.	413.	1958.	2101.	2236.	2592.
	14.	1465.	2989.	3035.	3069.	3084.
	15.	2861.	2855.	2602.	2697.	2596.
	16.	2462.	2356.	2313.	2269.	2142.
	17.	2451.	1946.	1909.	1873.	1768.
	18.	2022.	1606.	1575.	1545.	1459.
	19.	1465.	1318.	1213.	1244.	1171.
	20.	1377.	1067.	1041.	1020.	959.
	21.	1127.	830.	805.	719.	209.
	22.	480.	12.	8.	4.	0.
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BY DJM DATE _____
 CHKD. BY _____ DATE _____
 SUBJECT _____

LOUIS BERGER & ASSOCIATES INC.

MALAGA DAM

SHEET NO. 113 OF _____
 PROJECT _____

ROUTING THROUGH RESERVOIR									
ISTAG	ICOMP	1ECON	ITAPE	JPLT	JPRY	INAME			
11	1	0	0	0	0	1			
ROUTING DATA									
CLOSS	CLOSS	AVG	1RES	ISAME					
0.0	0.0	0.0	1	0					
NSTPS NSTEL LAG AMSKK X TSK STORA									
1	0	0.0	0.0	0.0	0.0	0.0			
STORAGE	Q	245	491	690	740	880	1031	1193	1354
OUTFLOW	Q	190	361	649	1258	3900	7105	11000	15915
TIME EOP STOR AVG IN EOP OUT									
1	1	0	0	0	0	0	0	0	0
2	2	0	0	0	0	0	0	0	0
3	3	0	0	0	0	0	0	0	0
4	4	0	0	0	0	0	0	0	0
5	5	0	0	0	0	0	0	0	0
6	6	0	0	0	0	0	0	0	0
7	7	0	0	0	0	0	0	0	0
8	8	0	0	0	0	0	0	0	0
9	9	0	0	0	0	0	0	0	0
10	10	0	0	0	0	0	0	0	0
11	11	0	0	0	0	0	0	0	0
12	12	0	0	0	0	0	0	0	0
13	13	0	0	0	0	0	0	0	0
14	14	0	0	0	0	0	0	0	0
15	15	0	0	0	0	0	0	0	0
16	16	0	0	0	0	0	0	0	0
17	17	0	0	0	0	0	0	0	0
18	18	1	1	1	4	7	1	1	1
19	19	1	1	1	7	11	1	1	1
20	20	2	2	2	11	15	2	2	2
21	21	3	3	3	15	20	3	3	3
22	22	5	5	5	20	25	4	4	4
23	23	6	6	6	25	30	6	6	6
24	24	8	8	8	30	36	7	7	7
25	25	11	11	11	36	42	9	9	9
26	26	14	14	14	42	48	11	11	11
27	27	17	17	17	48	54	14	14	14
28	28	20	20	20	54	61	16	16	16
29	29	24	24	24	61	68	19	19	19
30	30	28	28	28	68	76	22	22	22
31	31	33	33	33	76	84	26	26	26
32	32	38	38	38	84	92	29	29	29
33	33	43	43	43	92	101	33	33	33
34	34	49	49	49	101	111	38	38	38
35	35	55	55	55	111	122	42	42	42
36	36	62	62	62	122	133	47	47	47
37	37	69	69	69	133	148	53	53	53
38	38	77	77	77	148	170	59	59	59
39	39	86	86	86	170	201	67	67	67
40	40	98	98	98	201	248	77	77	77
41	41	112	112	112	248	311	90	90	90
42	42	131	131	131	311	390	107	107	107
43	43	155	155	155	390	481	127	127	127
44	44	185	185	185	481				

BY D.J.M. DATE _____

CHKD. BY _____ DATE _____

SUBJECT _____

LOUIS BERGER & ASSOCIATES INC.

MALAGA DAM

SHEET NO. A14 OF _____

PROJECT _____

45	222.	581.	152.
46	265.	689.	182.
47	315.	804.	220.
48	371.	925.	265.
49	434.	1051.	315.
50	502.	1181.	378.
51	576.	1316.	484.
52	652.	1455.	594.
53	718.	1598.	793.
54	756.	1742.	1567.
55	771.	1887.	1847.
56	780.	2030.	2007.
57	787.	2168.	2148.
58	794.	2300.	2281.
59	801.	2423.	2406.
60	807.	2537.	2521.
61	813.	2642.	2627.
62	818.	2737.	2723.
63	822.	2822.	2809.
64	826.	2896.	2885.
65	830.	2959.	2950.
66	833.	3012.	3004.
67	835.	3052.	3046.
68	836.	3080.	3076.
69	837.	3093.	3090.
70	837.	3089.	3090.
71	836.	3070.	3072.
72	834.	3034.	3039.
73	832.	2987.	2994.
74	829.	2935.	2942.
75	826.	2887.	2889.
76	824.	2828.	2816.
77	821.	2776.	2783.
78	818.	2723.	2731.
79	815.	2672.	2679.
80	813.	2621.	2628.
81	810.	2571.	2578.
82	807.	2522.	2529.
83	805.	2474.	2481.
84	802.	2427.	2434.
85	800.	2381.	2388.
86	797.	2334.	2342.
87	795.	2291.	2298.
88	793.	2248.	2254.
89	791.	2205.	2211.
90	788.	2163.	2169.
91	786.	2122.	2128.
92	784.	2082.	2087.
93	782.	2042.	2048.
94	780.	2003.	2009.
95	778.	1965.	1970.
96	776.	1924.	1933.
97	774.	1891.	1896.
98	772.	1855.	1860.
99	770.	1820.	1825.
100	768.	1785.	1790.
101	766.	1751.	1756.
102	765.	1718.	1722.
103	763.	1685.	1690.
104	761.	1653.	1658.
105	760.	1622.	1626.

BY DJM DATE _____
 CHKD. BY _____ DATE _____
 SUBJECT _____

LOUIS BERGER & ASSOCIATES INC.
MALAGA DAM

SHEET NO. 15 OF _____
 PROJECT _____

106	758.	1591.	1595.
107	756.	1560.	1565.
108	755.	1531.	1535.
109	753.	1502.	1506.
110	752.	1473.	1477.
111	750.	1445.	1449.
112	749.	1418.	1421.
113	747.	1391.	1394.
114	746.	1363.	1367.
115	744.	1335.	1338.
116	742.	1295.	1301.
117	740.	1258.	1264.
118	739.	1230.	1240.
119	737.	1205.	1217.
120	735.	1182.	1194.
121	733.	1160.	1171.
122	731.	1138.	1149.
123	729.	1116.	1127.
124	727.	1095.	1106.
125	726.	1074.	1084.
126	724.	1052.	1062.
127	722.	1030.	1041.
128	720.	1010.	1020.
129	719.	989.	999.
130	717.	963.	979.
131	715.	946.	957.
132	713.	919.	931.
133	711.	893.	906.
134	709.	867.	880.
135	707.	842.	855.
136	705.	817.	830.
137	701.	762.	784.
138	695.	669.	707.
139	685.	553.	642.
140	663.	354.	610.
141	627.	157.	559.
142	589.	64.	503.
143	551.	22.	448.
144	518.	19.	400.
145	486.	14.	358.
146	460.	10.	336.
147	433.	6.	315.
148	408.	2.	295.
149	385.	0.	276.
150	363.	0.	258.
SUM		172299.	

PEAK 3090. 6-HOUR 3069. 24-HOUR 2833. 72-HOUR 2095. TOTAL VOLUME 172299.
 CFS 3090. 3069. 2833. 2095.
 INCHES 0.98 3.62 8.04 9.18
 AC-FY 1522. 5623. 12473. 14247.

RUNOFF SUMMARY, AVERAGE FLOW

HYDROGRAPH AT	PEAK	6-HOUR	24-HOUR	72-HOUR	AREA
ROUTED TO	3095.	3071.	2835.	2112.	29.10
	11	3090.	3069.	2833.	29.10

DAT
FILM